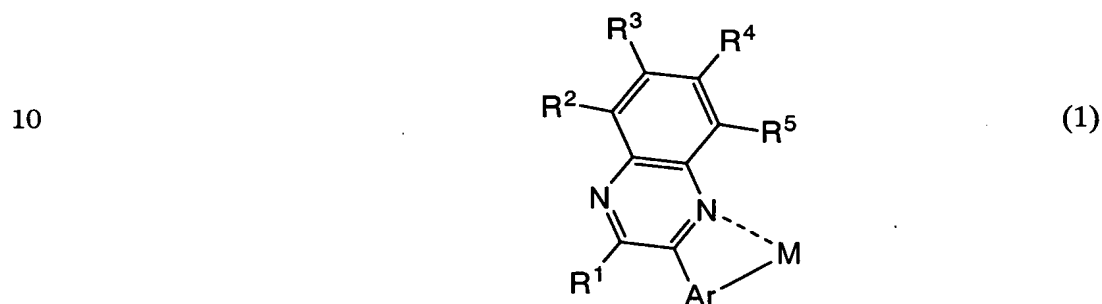


## CLAIMS

1. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

5 wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (1) and a compound that has a larger energy gap than the organometallic complex, and



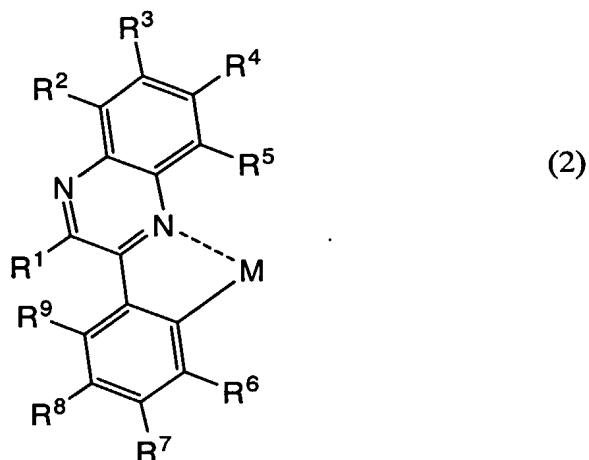
15 wherein each of **R**<sup>1</sup> to **R**<sup>5</sup> is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, **Ar** is one of an aryl group having an electron-withdrawing group and a heterocyclic group having an electron-withdrawing group, and **M** is one of an element of Group 9 and an element of Group 10.

20 2. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (2) and a compound that has a larger energy gap than the organometallic complex, and

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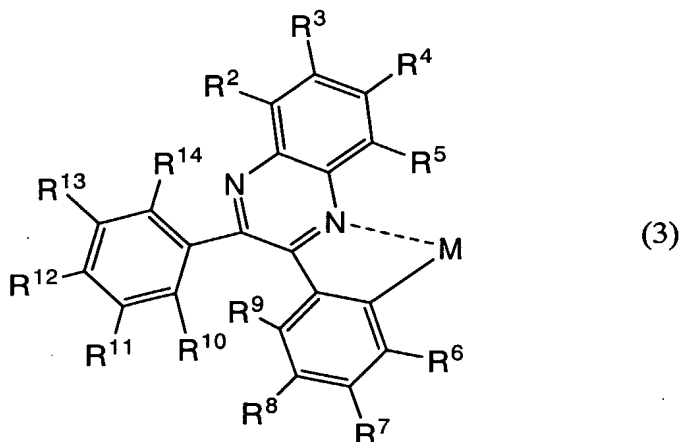
10        wherein each of  $R^1$  to  $R^9$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, at least one of  $R^6$  to  $R^9$  is an electron-withdrawing group, and  $M$  is one of an element of Group 9 and an element of Group 10.

15

3. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

      wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (3) and a compound that has a larger energy gap than the organometallic complex, and

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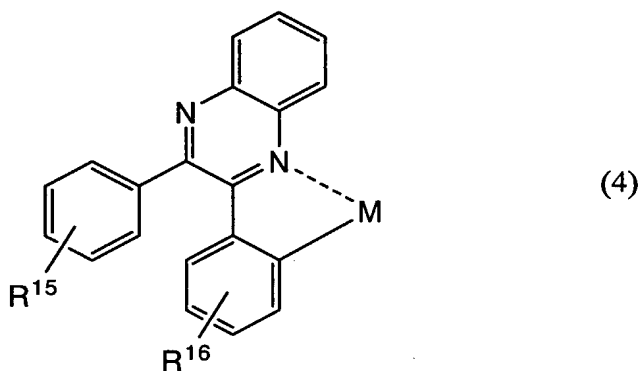
30        wherein each of  $R^2$  to  $R^{14}$  is selected from the group consisting of hydrogen, a

halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, and **M** is one of an element of Group 9 and an element of Group 10.

5           4. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

          wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (4) and a compound that has a larger energy gap than the organometallic complex, and

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          wherein each of **R**<sup>15</sup> and **R**<sup>16</sup> is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, and **M** is one of an element of Group 9 and an element of Group 10.

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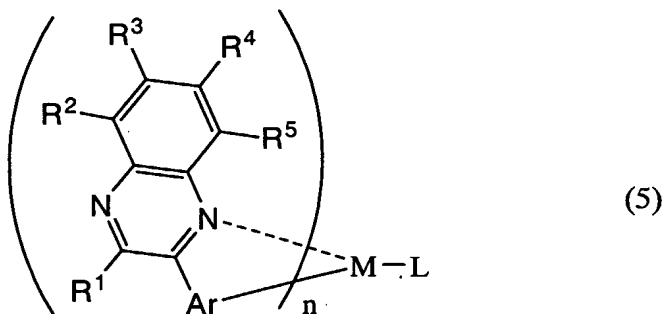
5. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

          wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (5) and a compound that has a larger energy gap than the organometallic complex, and

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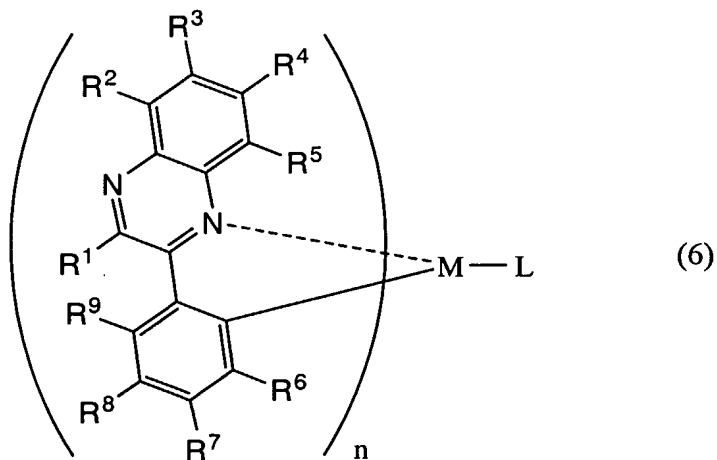


wherein each of  $R^1$  to  $R^5$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, Ar is one of an aryl group having an electron-withdrawing group and a heterocyclic group having an electron-withdrawing group,  $M$  is one of an element of Group 9 and an element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  $M$  is the element of Group 10, and  $L$  is an anionic ligand.

6. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (6) and a compound that has a larger energy gap than the organometallic complex, and

20



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wherein each of  $R^1$  to  $R^9$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a

cyano group, and a heterocyclic group, at least one of  $R^6$  to  $R^9$  is an electron-withdrawing group,  $M$  is one of an element of Group 9 and an element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  $M$  is the element of Group 10, and  $L$  is an anionic ligand.

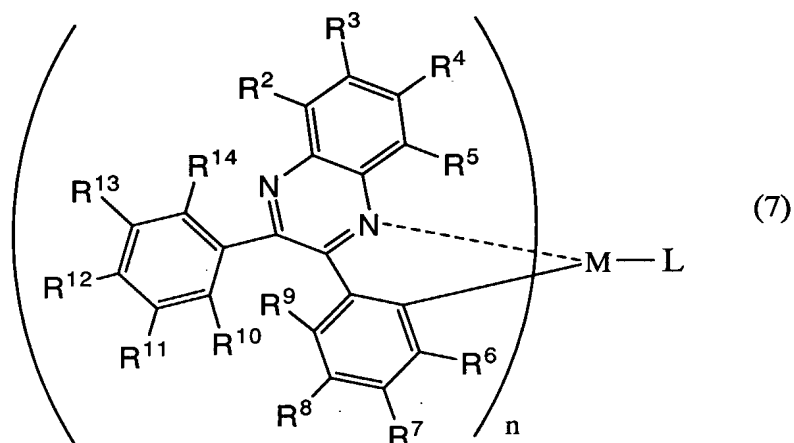
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7. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (7) and a compound that has a larger energy gap than the organometallic complex, and

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wherein each of  $R^2$  to  $R^{14}$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group,  $M$  is one of an element of Group 9 and an element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  $M$  is the element of Group 10, and  $L$  is an anionic ligand.

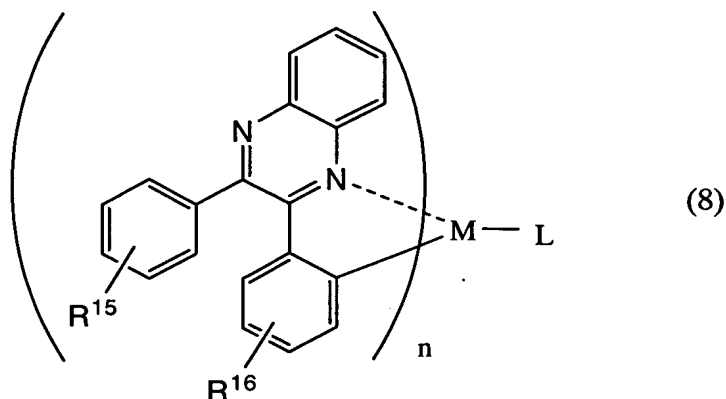
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8. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (8) and a compound that has a larger energy gap than the organometallic complex, and

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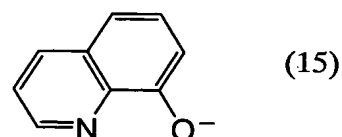
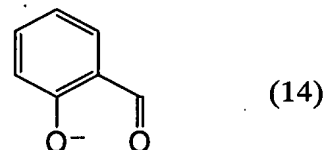
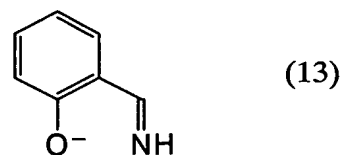
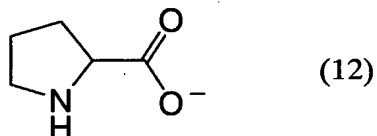
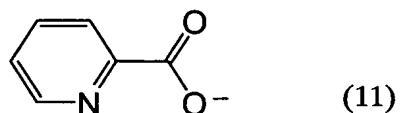
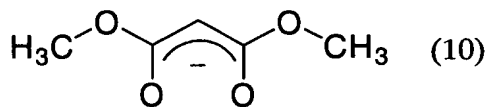
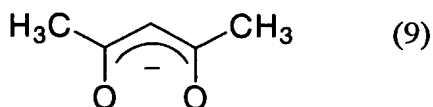


wherein each of  $R^{15}$  and  $R^{16}$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group,  $M$  is one of an element of Group 9 and an element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  $M$  is the element of Group 10, and  $L$  is an anionic ligand.

9. The light-emitting element according to any one of claims 1 to 8, wherein the compound that has the larger energy gap than the organometallic complex is one of 4, 4' - bis [N - (1 - naphthyl) - N - phenylamino] - biphenyl and tris (8 - quinolinolato) aluminum.

10. The light-emitting element according to any one of claims 5 to 8, wherein the anionic ligand  $L$  is one of an anionic ligand having a  $\beta$ -diketone structure, an anionic bidentate ligand having a carboxyl group, and an anionic bidentate ligand having a phenolic hydroxyl group.

11. The light-emitting element according to any one of claims 5 to 8, wherein the anionic ligand  $L$  is a ligand represented by any one of the following formulas (9) to (15).



12. The light-emitting element according to any one of claims 1 to 8, wherein the light-emitting layer includes the organometallic complex and one of a first compound that has a larger energy gap than the organometallic complex and has an electron mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more and a second compound that has a larger energy gap than the organometallic complex and has a hole mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more.

13. The light-emitting element according to any one of claims 1 to 8, wherein the light-emitting layer includes the organometallic complex, a first compound that has a larger energy gap than the organometallic complex and has an electron mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more, and a second compound that has a larger energy gap than the organometallic complex and has a hole mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more.

14. The light-emitting element according to claim 12, wherein the first compound is a metal complex, and the second compound is an aromatic amine compound.

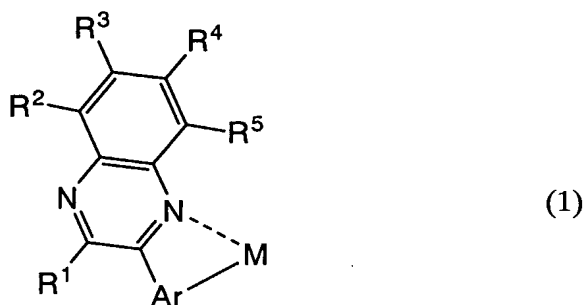
15. The light-emitting element according to claim 13, wherein the first compound is a metal complex, and the second compound is an aromatic amine compound.

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16. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (1) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and

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wherein each of **R**<sup>1</sup> to **R**<sup>5</sup> is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, **Ar** is one of an aryl group having an electron-withdrawing group and a heterocyclic group having an electron-withdrawing group, and **M** is one of an element of Group 9 and an element of Group 10.

17. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

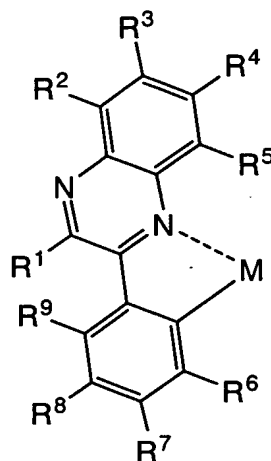
wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (2) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and

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(2)

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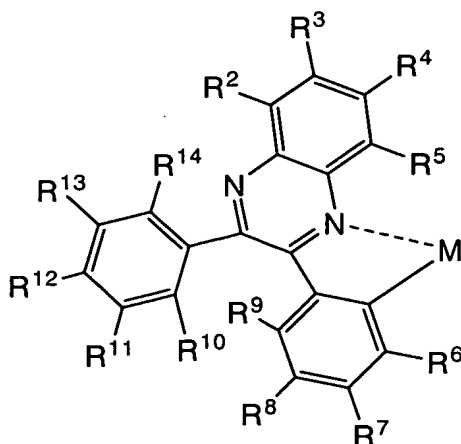
wherein each of  $R^1$  to  $R^9$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, and  $M$  is one of an element of Group 9 and an element of Group 10.

18. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (3) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and

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(3)

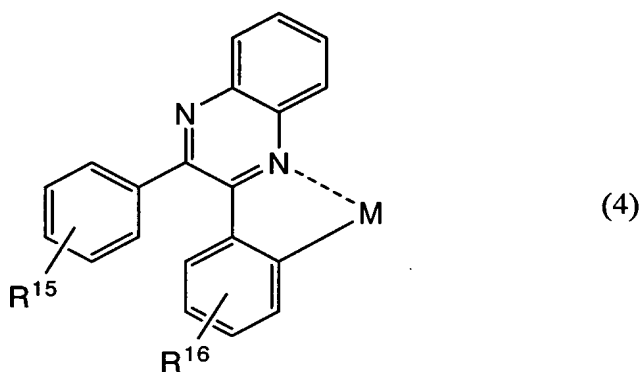
wherein each of  $R^2$  to  $R^{14}$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, and  $M$  is one of an element of Group 9 and an element of Group 10.

5

19. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex having a structure represented by the following general formula (4) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and

15



wherein each of  $R^{15}$  and  $R^{16}$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group, and  $M$  is one of an element of Group 9 and an element of Group 10.

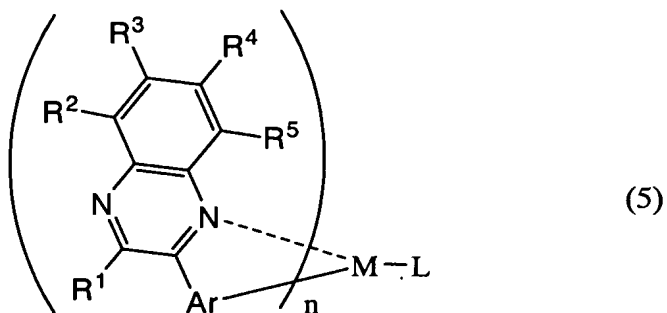
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20. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

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wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (5) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and

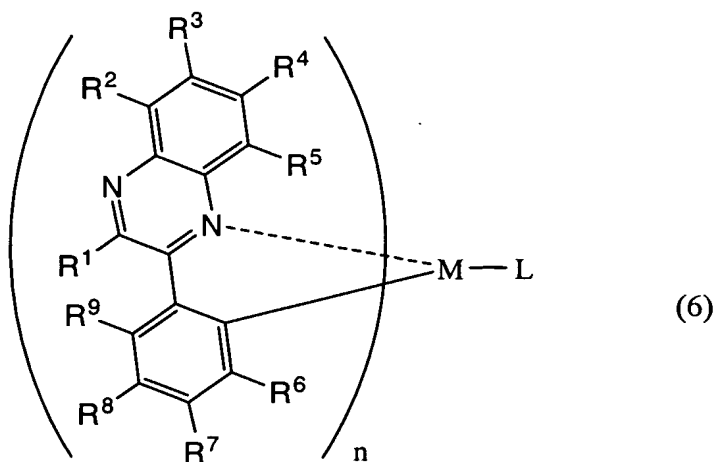
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wherein each of  $R^1$  to  $R^5$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group,  $Ar$  is one of an aryl group having an electron-withdrawing group and a heterocyclic group having an electron-withdrawing group,  $M$  is one of an element of Group 9 and an element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  $M$  is the element of Group 10, and  $L$  is an anionic ligand.

15 21. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (6) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and



25 wherein each of  $R^1$  to  $R^9$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a

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cyano group, and a heterocyclic group, at least one of  $R^6$  to  $R^9$  is an electron-withdrawing group,  $M$  is one of an element of Group 9 and an element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  $M$  is the element of Group 10, and  $L$  is an anionic ligand.

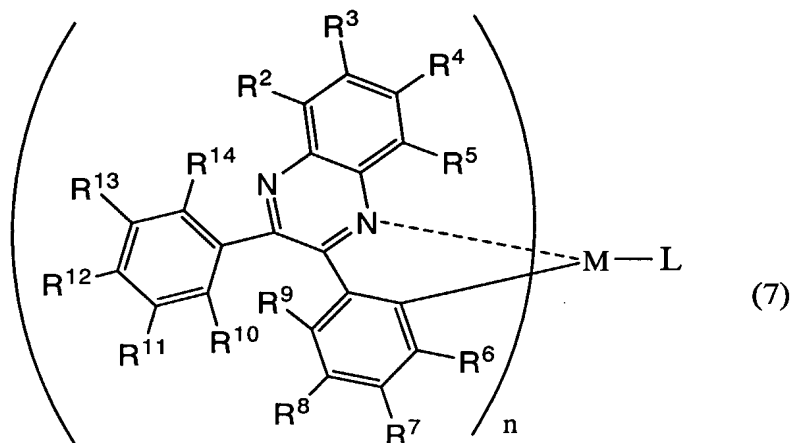
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22. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (7) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and

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wherein each of  $R^2$  to  $R^{14}$  is selected from the group consisting of hydrogen, a halogen element, an acyl group, an alkyl group, an alkoxyl group, an aryl group, a cyano group, and a heterocyclic group,  $M$  is one of an element of Group 9 and an element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  $M$  is the element of Group 10, and  $L$  is an anionic ligand.

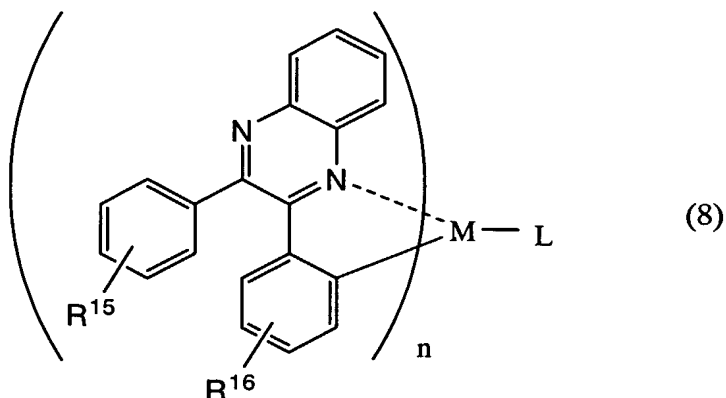
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23. A light-emitting element comprising a light-emitting layer between a pair of electrodes,

wherein the light-emitting layer comprises an organometallic complex represented by the following general formula (8) and a compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex, and

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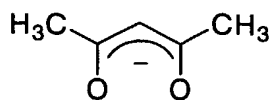
wherein each of  $R^{15}$  and  $R^{16}$  is selected from the group consisting of hydrogen,  
 10 a halogen element, an acyl group, an alkyl group, an alkoxy group, an aryl group, a  
 cyano group, and a heterocyclic group,  $M$  is one of an element of Group 9 and an  
 element of Group 10,  $n = 2$  when the  $M$  is the element of Group 9 while  $n = 1$  when the  
 $M$  is the element of Group 10, and  $L$  is an anionic ligand.

15 24. The light-emitting element according to any one of claims 20 to 23,  
 wherein the anionic ligand  $L$  is one of an anionic ligand having a  $\beta$ -diketone structure,  
 an anionic bidentate ligand having a carboxyl group, and a monoanionic bidentate  
 ligand having a phenolic hydroxyl group.

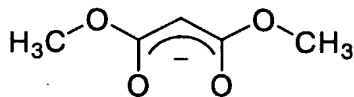
20 25. The light-emitting element according to any one of claims 20 to 23,  
 wherein the anionic ligand  $L$  is a ligand represented by any one of the following  
 formulas (9) to (15).

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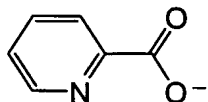
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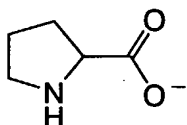
(9)



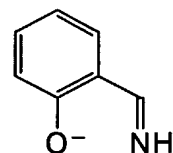
(10)



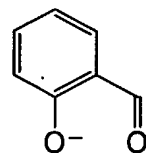
(11)



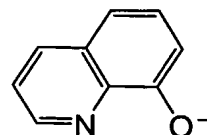
(12)



(13)



(14)



(15)

26. The light-emitting element according to any one of claims 16 to 23, wherein the light-emitting layer includes the organometallic complex and one of a first compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex and has an electron mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more and a second compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex and has a hole mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more.

27. The light-emitting element according to any one of claims 16 to 23, wherein the light-emitting layer includes the organometallic complex, a first compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex and has an electron mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more, and a second compound that has a larger ionization potential and a smaller electron affinity than the organometallic complex and has a hole mobility of  $10^{-6}$  cm<sup>2</sup>/Vs or more.

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28. The light-emitting element according to claim 26, wherein the first compound is a metal complex, and the second compound is an aromatic amine compound.

29. The light-emitting element according to claim 27, wherein the first

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compound is a metal complex, and the second compound is an aromatic amine compound.

30. The light-emitting element according to any one of claims 1 to 8, further  
5 comprising at least one of a hole injecting layer, a hole transporting layer, a hole blocking layer, an electron transporting layer, and an electron injecting layer.

31. The light-emitting element according to any one of claims 16 to 23, further  
10 comprising at least one of a hole injecting layer, a hole transporting layer, a hole blocking layer, an electron transporting layer, and an electron injecting layer.

32. A light-emitting device using the light-emitting element according to any one of claims 1 to 8.

15 33. A light-emitting device using the light-emitting element according to any one of claims 16 to 23.